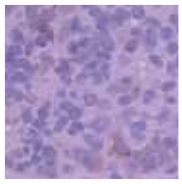
SEEDS

SEEDS:
The OARDC Research Enhancement Competitive Grants Program

REPORT OF PROGRESS FOR CALENDAR YEAR 2007



Ohio Agricultural Research and Development Center

The Ohio State University

THE OHIO STATE UNIVERSITY OARDC

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For more information, visit our web site at:
http://www.oardc.ohio-state.edu/seeds

SEEDS

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Current and Past Industry Partners

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6062 Holdings, LLC

AccuDX, Inc.

Ag-Spectrum

Alltech

Alpaca Jack's Suri Farm

American Aggregates Corp.

American Coal Ashland Association

American Hosta Society

Ampac Seed Company

Anonymous

Antorchas Foundation

Archer-Daniels-Midland Company

Argus Control Systems, Ltd.

Asgrow Seed Company

Athersys, Inc.

Aviagen

BASF Plant Science GmbH Agrarzentrum Limburgerhof

Bass Endowment

Bayer Corporation

Bayer CropScience LP Environmental Sciences

Bedding Plants Foundation, Inc.

Berlin Natural Baker, Inc.

Biotechnology Research and Development Corporation

Boehringer Ingelheim-NOBL

British Columbia Greenhouse Growers' Association

British United Turkeys of America

California Avocado Commission

Camelid Health Foundation

Campbell R and D

Cargill Animal Nutrition Center

Cattlemen's Carcass Data Service

Center for Asceptic Processing and Packaging Studies

Central Ohio Hosta Society

Certified Angus Beef

Ciba Crop Protection

Cinergy

City of Columbus

Cognis Deutschland GmBH and Co.

Consortium for Plant Biotechnology Research

Cooper Farms, Inc.

Cultiva

Dairy Management, Inc.

Danone

DeVenture

Donlar Corporation

Dow Agrosciences

Dynal Biotech

E. I. DuPont de Nemours and Co.

Eagle-Picher Minerals, Inc.

Earthgro

Edstrom Industries, Inc.

Elanco Animal Health

Eli Lilly and Company

Farmland Industries

First Energy

Floriculture Industry Research and Scholarship Trust

Food Science Australia

Fremont Pickle Growers Association

Fruit Growers Marketing Association

Garick

General Chemical

George F. Ackerman Company

Great Lakes Hosta Society

Gregson Technologies, Inc.

Gustafson, Inc.

Harris Moran Seed Company

Hillshire Farm and Kahn's

Hirzel Canning Co.

Holmes Cheese Company

Holmes Cheese Table

Horticultural Research Institute

Iams Corporation

Infectech, Inc.

Ingredient Innovations International

Integrated Research Technology, LLV

J. Frank Schmidt Family Charitable Foundation

Jarrow Incorporated

Jatco, Inc.

Kamiasahi Feed Lot, Ltd.

Kanter Associates

Kohlpyr

Kraft Foods Global, Inc.

Kurtz Brothers, Inc.

Lilly Research Laboratories

Lipha Tech, Inc.

Lipton Tomato Research Center

Loveland Industries, Inc.

Magical Farms, Inc.

Maple Leaf Farms, Inc.

Martek Biosciences Corporation

Merial Limited

MicroBio Limited

Mid-America Food Processors

Middlefield Cheese

Midtech

Midwest Regional Hosta Society

Ministry of Culture, Education, and Scientific Exchanges, Spain

National Fish and Wildlife Foundation

National Sea Grant Program

National Wildlife Federation

Natural Fiber Composites Corporation

North American Strawberry Growers Research Foundation, Inc.

Nourse Farms, Inc.

Novartis Crop Protection, Inc.

Nursery Growers of Lake County Ohio, Inc.

N-Viron International, Inc.

Ohio Bioprocessing Research Consortium

Ohio Corn Marketing Program

Ohio Dairy Farmers Federation, Inc.

Ohio Dairy Producers

Ohio Floriculture Foundation

Ohio Fruit Growers Society

Ohio Lawn Care Association

Ohio Nursery and Landscape Association, Inc.

Ohio Pork Producers Council

Ohio Poultry Association

Ohio Seed Improvement Research

Ohio Sheep and Wool Program

Ohio Soybean Council

Ohio Space Grant Consortium

Ohio Vegetable and Small Fruit Research and Development

Ontario Greenhouse Vegetable Growers

Optimum Quality Grains, LLC

Otterbein College

Outback

Park Foundation

Pennington Seed, Inc., Oregon Division

Petroseed

Pfizer

Pharmacia, Wyeth Ayterst Research

Philip Morris, Inc., Shared Solutions in Agriculture

Phycotransgenics

PIC USA

Pig Improvement Company

Pioneer Hibred International, Inc.

Polter Berry Farm

Protein Technologies International

Purity Foods, Inc.

Quality Liquid Feeds

Rainbow Treecare Scientific Advancements

Rainforest Phytoceuticals

Raven

Rhodia, Inc.

Roche Vitamins, Inc.

Satloc

Select Sires

Seminis Vegetable Seeds, Inc.

Small Farm Institute

Syngenta

The Chef's Garden, Inc.

The Garland Company, Inc.

The HANOR Company, Inc.

The Scotts Company and Subsidiaries

Theis Technology, Inc.

Thomas Cook

Toh Products, LLC

Top Soil Precision Ag

Tree Research and Education Endowment Fund

TruGreen-Chemlawn

Turkish Republic Harran University

Valent USA Corp.

Warner Endowment Grant

West Texas A and M

Wilmington College

SEEDS:
The OARDC Research Enhancement Competitive Grants Program

Year after year the No. 1 industry in Ohio remains the same. No other economic engine comes close to making the kind of impact generated by agriculture, food, and the nursery and landscape industry. This economic powerhouse yields more than $80 billion annually, employs one in every six Ohioans, and supports a diversified and dynamic economic sector that touches the lives of everyone in the state.

All citizens of Ohio are intertwined in the food, agriculture, and nursery and landscape industry. Producers, processors, and consumers all rely on quality, state-of-the-art research to help them make informed decisions and deal effectively with the wide array of challenges that come along the way. Those challenges are quite varied and may include anything from livestock and crop production issues, packaging and product development, to food safety and nutrition.

With the changing nature of economic and societal trends as well as the impact of globalization, agriculture, food, and the green industry also depend on innovators and researchers to generate new processes or products. Ohio's largest industry increasingly links with other industries to take on common challenges and opportunities in key areas such as environmental restoration or the development of bio-renewable sources of energy, fuel, and industrial goods.

Addressing the differing challenges and vast opportunities of Ohio's largest industry is the ultimate goal of SEEDS: The Research Enhancement Competitive Grants Program. SEEDS promotes excellence in Ohio Agricultural Research and Development Center (OARDC) research, promoting research consistent with the mission and vision of OARDC and encouraging connections across disciplines, with industry and other external partners. It isn't just Ohio citizens who benefit from this cutting-edge research. The results from OARDC's innovations enhance quality of life around the globe.

Established in 1996 and supported by an appropriation from the Ohio General Assembly to OARDC, SEEDS: The Research Enhancement Competitive Grants Program is unique among U.S. state-assisted universities. In fostering high-quality research among OARDC- and College of Food, Agricultural, and Environmental Sciences-supported scientists, SEEDS enables those scientists to collect the preliminary data needed to give them a competitive edge in national programs and provides them with leverage to attract industry support.

Objectives

Seeds was created to encourage partnerships with industry and other stakeholders and to increase the competitiveness of OARDC/CFAES scientists in extramural grant programs. While these objectives remain the program's cornerstone, SEEDS has grown to include a total of seven objectives:

- Increase the competitiveness of scientists in extramural grant programs.
- Encourage partnerships with industry and other stakeholders.
- Encourage the development of interdisciplinary teams.
- Encourage international collaborations.
- Support the exploration of enterprises that are potentially new to Ohio.
- Provide undergraduate students with research experience.
- Provide graduate students with the opportunity to take part in the grant-writing/review process.

By providing seed money to develop the necessary preliminary data for a strong grant application or by matching funds to leverage external funding, SEEDS has proved to be a valuable program for scientists in the College of Food, Agricultural, and Environmental Sciences. The SEEDS program looks forward to continued success and new partnerships with industry and other collaborators in Ohio and the world within the context of our global society.

Program Achievements

Overall, SEEDS has supported research projects in the amount of $8 million in all categories and has received close to $40 million in matching and extramural funding—a return of about $5.00 for each dollar invested. SEEDS or SEEDS-funded researchers have:

- Invested $1,683,268 in projects requiring matching funds, generating $3,373,377 in industry matches—a return of $2.00 on each dollar invested.
- Enabled scientists to establish collaborations with colleagues from Africa, Argentina, Australia, Belgium, Brazil, Chile, France, New Zealand, Norway, the Philippines, Switzerland, Taiwan, Uganda, and Zimbabwe.
- Applied for nine U.S. patents using results of initial findings. Three patent applications have been granted, and three licensing agreements have been obtained.
- Published a total of 576 peer-reviewed scientific manuscripts, abstracts, popular press articles, bulletins, and/or book chapters and made more than 1,100 presentations throughout the world.
- Seeds-supported graduate students have produced 23 doctoral dissertations and 62 master's theses.

Achievements by Objectives

Objective 1—Increasing the competitiveness of scientists in extramural grant programs.

The Seed Grant Competition and the Agency External Competitions specifically address Objective 1. However, all the other competitions may result in additional funding from outside sources.

Of the 21 projects completed and reported in calendar year 2007, $793,697 was generated in extramural funding. Over the life of SEEDS, 249 projects have been completed and $33,307,555 has been generated extramurally.

Over the life of SEEDS, OARDC has invested $488,362 in matching funds for Agency External Grants which generated $2,916,153 in extramural funding, a return of more than $5.00 for each dollar invested.

Objective 2—Encouraging partnerships with industry and other stakeholders.

The Matching and Industry Small Grant Competitions address Objective 2.

Of the 10 grants requiring at least a dollar-for-dollar match and completed during calendar year 2007, OARDC provided a total of $38,410 while industry matched those dollars with $47,015.

For the life of the program, OARDC has provided $1,683,268 toward Matching and Industry Small Grants while industry matched these dollars with $3,373,377 — a return of $2.00 on each dollar invested.

Objective 3—Encouraging the development of interdisciplinary teams.

The Interdisciplinary Team Competition specifically addresses Objective 3.

During calendar year 2007, five interdisciplinary teams completed projects. These teams reported receiving $793,697 in extramural funding.

Over the life of the program six colleges and 23 departments have participated in this category of competition with OARDC investing $3,146,503 and teams competing successfully and reporting $8,763,315 in extramural funding — a return of $2.78 on each dollar invested.

Objective 4—Encouraging international collaborations.

All competitions may have an international collaboration component, and international relationships are encouraged. OARDC scientists have collaborated with scientists from Africa, Argentina, Australia, Belgium, Brazil, Chile, France, Italy, New Zealand, Norway, the Philippines, Switzerland, Taiwan, Uganda, and Zimbabwe.

Over the life of SEEDS, OARDC has invested $488,362 in matching funds for Agency External Grants which generated $2,916,153 in extramural funding, a return of more than $5.00 for each dollar invested.

Objective 5—Support the exploration of enterprises that are potentially new to Ohio.

New Enterprises are considered to be crops, animals, products, goods, and services that currently are not produced for biological, physical, cultural, processing, economic, or social reasons. The New Enterprise Competition is designed to explore new enterprises and to eliminate the barriers that constrain existing ones.

The New Enterprise Competition has received 25 applications; 10 have been funded.

Funded projects include:

- New Commodity Enterprises in Ohio — Evaluation and Education
- Development of New Biological Products for Slug Control
- Direct Conversion of Agricultural Wastes to Electricity Using Rumen Microbes in Microbial Fuel Cells
- Domestication and Commercialization of *Paraxacum* — A New Crop to Fuel Ohio's Agricultural and Rubber Industry

Objective 6—Providing undergraduate students with research experience.

A total of 42 applications to the Director's Undergraduate Research Program have been received. Thirty applicants have received awards.

The Director's Undergraduate Research Program provides undergraduate students with a professional grant writing, research, and reporting experience. Projects are designed, submitted for review, and carried out with a faculty mentor. Once the project is completed, students take an independent studies class to write their research report in the form of a scientific journal article, using their faculty advisor as an editor. Some of these reports have been published. In addition, many students present their research at professional meetings and at competitions such as the Denman Undergraduate Research Forum, a university-wide program presented by the Ohio State University Office of Research and the University Honors and Scholars Center.

Examples of research recently funded in the Undergraduate Competition include:

- Evaluation of the Effectiveness and Behavior of Two Innovative Storm Water Management Practices
- A Market and Functionality Comparison of Organic and Conventional Food Ingredients: Are NOP Regulations a Foundation for Growth or an Impossible Standard?
- Effects of Different Diets on the Fatty Acid Concentrations in Milk from Dairy Cows and the Corresponding Impact on Taste and Texture of Cheese

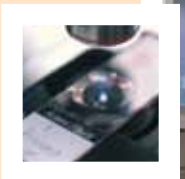
Objective 7—Providing graduate students with the opportunity to take part in the grant-writing/review process.

A total of 302 master's and doctoral students have submitted proposals in this competition. One hundred thirty projects have been awarded. The graduate competition is run exactly like a federal competition. Graduate students who receive awards are asked to serve on a panel to review applications in the following year's competition. This experience provides students with an opportunity to develop their skills in grant-writing and reviewing — skills essential for them in their professional careers.


Aerobic Reactor
(Tank 8)

Interdisciplinary Team Competition

The Interdisciplinary Team Grant Competition, funded at a maximum level of $100,000, is designed to stimulate new collaborative partnerships in multiple departments and colleges or build on existing programs of excellence. Interdisciplinary research provides expertise over several disciplines, bringing a more holistic approach to research questions and problems.

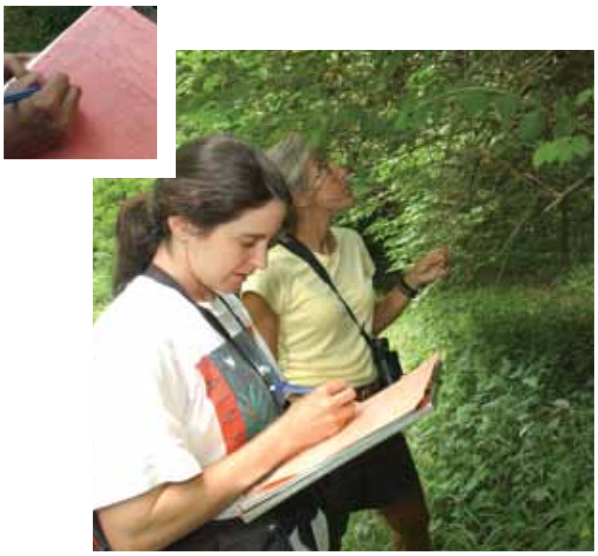


After the Invasion: Developing a Mechanistic Understanding of Ecological and Human Responses to Exotic Species to Inform Restoration Decisions

Joseph L. Arvai, Virginie L. Bouchard, and Amanda D. Rodewald, School of Environment and Natural Resources
Maria Miriti, Evolution, Ecology, and Organismal Biology

Exotic plants can profoundly alter ecosystem structure and function and are serious threats to native biodiversity. Because the frequency and severity of invasions continue to rise with increasing fragmentation and changing land uses, most ecosystems will be influenced to some degree by exotic plants. Consequently, eradication and control of exotic plants is a common element in most ecological restoration efforts. Effective restoration of invaded sites is seriously compromised by our poor understanding of the ecological mechanisms that are responsible for the impacts of exotic plant invasions as well as the responses of experts and non-technical participants to management choices for environmental restoration.

The focus of this research was on Amur honeysuckle *(Lonicera macckii),* one of the most problematic invasive plants in forests of the eastern United States. Studies have confirmed that honeysuckle negatively impacts native plants, including spring wildflowers, understory shrubs, and tree saplings. Honeysuckle may modify carbon and nitrogen cycling in woodland litter and soil, thus contributing to its own survival.



More recent work shows that animal communities may be negatively impacted by honeysuckle both through habitat modification and alteration of predator-prey interactions. For example, birds nesting in honeysuckle experience higher rates of nest predation than birds nesting in native plants. Even less understood are the impacts of honeysuckle on recreation and public safety, which include higher incidences of bicycle accidents along bike paths lined by dense honeysuckle. For these reasons, control of honeysuckle is a critical forest management and ecological restoration issue.

This project aimed to inform ecological restoration efforts in riparian and urban systems by understanding the mechanisms by which Amur honeysuckle successfully invades an ecosystem and modifies plant community structure; identifying how honeysuckle impacts carbon and nitrogen cycling, potentially providing positive feedback for its own invasion; determining the impacts of honeysuckle on avian populations and interactions between birds and nest predators; and developing tools to promote sound decision-making by understanding individual judgments about ecological restoration options. The OARDC SEED grant provided funding to initiate the study and collect pre-treatment data.

Working in eight study grids in riparian forests along the Olentangy River in Columbus, Ohio, scientists combined observational and experimental approaches to understanding the impact of honeysuckle. Honeysuckle vegetation was completely removed on four experimental grids, whereas on four paired controls, vegetation was not manipulated. Seedlings were planted underneath, at the edge of, and away from honeysuckle canopies. Initial results confirmed that the presence of honeysuckle negatively affects survivorship of herbaceous understory species. Preliminary data also suggested that honeysuckle has the potential to impact carbon and nitrogen cycling, with leaves of the honeysuckle accounting for 16 to 19 percent of the leaf litter biomass and 13 to 15 percent of the total litter biomass. Post-treatment data collection on plant survival and carbon and nitrogen cycling is currently underway.

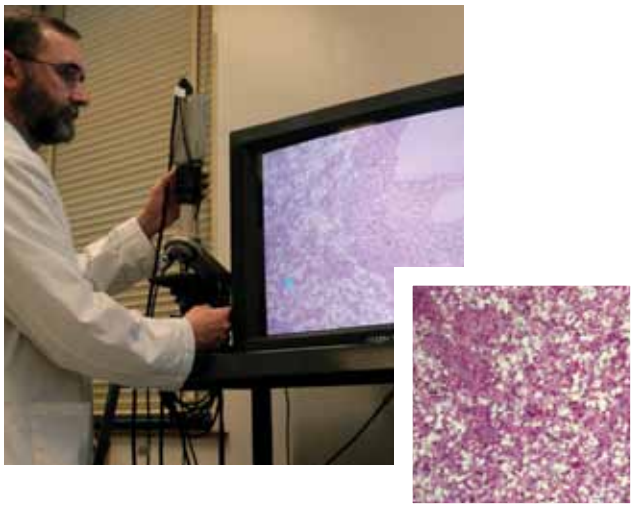
Surveys of the avian community pre- vs. post-treatment indicated that the presence of honeysuckle facilitated greater densities of certain resident and short-distance migratory species, such as the Northern Cardinal *(Cardinalis cardinalis)* and American Robin *(Turdus migratorius).* Scientists also found that relative predation rates of nests in native and exotic substrates changed over the course of the breeding season and were greatest for nests early in the breeding season, when only 14 percent of nests survived in honeysuckle compared to 24 percent of nests in other substrates. Ongoing work examines responses of avian nest predators to altered bird densities and modified habitat structure that result from honeysuckle removal.

Research on individual judgments about ecological restoration options suggests that the success of initial restoration efforts has the potential to affect subsequent decision-making of stakeholders. After chronic losses *(e.g.,* failed restoration efforts), subjects reported feeling helpless and took fewer risks as they related to future decisions. As part of this research, series of multi-stakeholder workshops related to climate change and invasion biology were held. Decision aids developed for these workshops have proved useful in terms of helping stakeholders to clarify issue-specific concerns, design restoration plans, and address complex tradeoffs.

As scientists move forward with this research, continued progress is expected to improve the linkages among the ecological and social research components. In addition to supporting student research experiences at graduate and undergraduate levels, this SEEDS grant allowed researchers to leverage $439,677 to date from various sources such as the National Science Foundation; the Ohio Department of Natural Resources, Division of Wildlife; and the Environmental Challenge Fund.

Manipulation of Vascular Endothelial Growth Factor (VEGF) to Regulate Reproductive Efficiency

Joseph S. Ottobre and Henry N. Zerby, Animal Sciences
Douglas R. Danforth, Obstetrics and Gynecology
Pravin T. P. Kaumaya, Medical Biochemistry

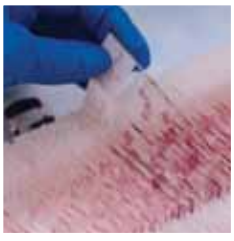


Reproductive inefficiency and infertility affects both the human and animal world. Infertility is a source of major economic loss in the animal industry and causes both emotional and financial stress among humans who experience infertility. Studies designed to enhance our basic understanding of reproductive physiology, including ovarian function, will ultimately benefit both domestic animals and humans.

The purpose of this research was to investigate the role of Vascular Endothelial Growth Factor (VEGF) and Endocrine Gland VEGF (EG-VEGF) in the regulation of early follicle growth in the sheep ovary and in the regulation of *corpus luteum* function in the sheep ovary. Vascular Endothelial Growth Factor is important for blood vessel development in a variety of tissues including an ovarian structure, the *corpus luteum* (CL). The CL is a transient endocrine gland that secretes progesterone, which prepares the uterus for pregnancy. In the absence of pregnancy, the *corpus luteum* regresses in response to uterine-derived prostaglandin. Deficiencies in luteal function during early pregnancy may result in embryonic loss. Understanding of the mechanisms of luteal function could aid in the development of new methods to regulate fertility for domestic animals as well as humans.

The objectives of the research were to investigate the role of VEGF and EG-VEGF in the regulation of early follicle growth in sheep and whether disruption of endogenous VEGF or EG-VEGF alters ovarian function and disrupts estrous cycles.

This study was designed to provide the first detailed information on the potential role of vascular growth factors in the regulation of early follicular growth in the sheep ovary, to examine the mechanism of luteal regression in sheep, and to provide important insight into the feasibility of manipulating this system for therapeutic benefit and/or regulating reproductive efficiency.



Recent data suggest that Vascular Endothelial Growth Factor may modulate many aspects of ovarian function, including follicle recruitment, selection, dominance, and *corpus luteum* formation and function. However, the role of VEGF in early follicle growth has been largely unexplored.

To assess whether VEGF is important in the regulation of early follicular growth, in sheep specifically, researchers initiated a study investigating the effects of neutralization of endogenous VEGF on ovarian function in ewe lambs. Prepubertal female lambs were immunized against VEGF, EG-VEGF, or a control peptide at five months of age. If immunization against the treatments affected the onset of follicular development, scientists would expect a delay in puberty. Although the lambs immunized against VEGF or EG-VEGF developed antibodies against the respective treatments, the antibody titers were not very high, and there was no significant effect of immunization on onset of puberty.

Prepubertal ewe lambs, approximately 20 weeks of age, were treated with VEGF in the artificial sac of one ovary, and a corresponding volume of vehicle was administered to the opposite ovary. Ovaries were removed 72 hours later and prepared for histological sectioning, so that they could be microscopically studied.

Based on preliminary trials, researchers were encouraged to believe that VEGF directly influenced the growth of primary and secondary follicles. Future studies are planned to further explore the previous model of luteal regulation.

The Waterman Ecological Treatment System (WETS)

Jay F. Martin, Food, Agricultural, and Biological Engineering
Armando Hoet and Clifton M. Monahan, Veterinary Preventive Medicine
Martin F. Quigley, Horticulture and Crop Science

Disposal and treatment of wastewater is a challenge facing all animal production facilities. The many negative factors resulting from animal wastes include decreased efficiency, decreased environmental quality both on-site and downstream, increased costs, and negative social perceptions.

As the rural-urban interface becomes more complex, especially in Ohio, comprehensive treatment of animal waste, rather than dilution or disposal, must become both energy efficient and ecosystem appropriate. Because of the negative impact of agricultural waste upon the quality of the nation's waters, the U.S. Environmental Protection Agency has recently proposed new, stricter regulations for wastewater from these facilities (US EPA 2001). The overall goal of this SEEDS-supported project was to develop and test a prototype ecological treatment system to treat and utilize dairy wastewater.

This project's interdisciplinary team included an ecological engineer, an expert in aquatic and riparian vegetation, and an expert in animal pathogens. The team came together to design and build a treatment system specifically to address the wastewater problems of an animal production facility by exploiting naturally occurring living organisms.

The Waterman Ecological Treatment System (WETS) created at The Ohio State University's Waterman Farm on the Columbus campus is based on similar ecological systems used to purify municipal and industrial wastewaters and a successful lab-scale treatment system.

For WETS, aerobic and anaerobic reactors, planted clarifiers, and planted wetlands were designed and enclosed in a polyhouse or hoop house at the dairy facility on the Waterman Farm. A constant stream of dairy wastewater was added to the system with a total of 1,310 liters of water being treated daily.

Using this system it was found that the WETS successfully treated dairy wastewater, which can then either be reused or discharged safely. Total solids and carbon were reduced significantly as were nitrogen and phosphorous. Reducing carbon is important since carbon released into streams causes oxygen levels to be reduced, resulting in fish kills and negative impacts on other wildlife. WETS consistently reduced total coliform and E. coli concentrations by at least 96 percent from influent to effluent and completely eliminated Salmonella from the effluent. Furthermore, a major advantage of this type of system is that it uses solar energy to drive the treatment processes, rather than relying on fuel.

The study also explored the potential for creating value-added products, such as ornamental plants and vegetables grown through hydroponics. The potential for this is extremely high because the wastewater moving through the system is nutrient dense. However, additional experiments need to be conducted to determine feasibility, and these experiments are being planned.

The team has continued to test the ability of the system to treat different amounts of liquid manure, and those tests are currently being analyzed. Results of this additional experiment will help determine the limitations of the system and aid in the design of an actual on-farm system.

This SEEDS-supported project successfully leveraged funds in the amount of $119,000 from the U.S. Department of Agriculture. The next step to building on the successful results of this project will be to better define the ability of the system to reduce pathogen concentrations and test the system scaled to a larger facility.

Quantifying Ecological Risk from Agricultural Land Treated with Biosolids

Joseph L. Arvai and Nicholas Basta, School of Environment and Natural Resources
Roman Lanno, Entomology

The annual application of five million tons of waste materials such as biosolids *(i.e.,* sewage sludge, animal manure, and industrial by products such as coal fly ash) to agricultural land in the United States provides economic benefits to producers as well as societal benefits associated with the safe disposal of these otherwise undesirable waste products. At the same time, routine management practices, such as the application of fertilizer, use of copper or arsenic-based pesticides, and land application of biosolids, introduce small amounts of metals into agricultural land. The risk posed to ecological receptors from additions of these small amounts of metals is unclear. Therefore, it is critical to determine the risk posed from low to intermediate levels of metals to allow benefits to be realized without damaging soil or ecosystem resources.

In the absence of scientific risk-based guidelines, some states have adopted overly conservative and unrealistic guidelines. US EPA Ecological Soil Screening Levels (EcoSSLs; US EPA 2005) are broad, conservative screening values. The actual risk posed by agricultural practices to soil ecosystems may be minimal even when metal levels exceed screening levels, necessitating a site-specific evaluation of risk. For example, concern over arsenic contamination of soil and water has led to adopting soil screening levels of 2.1 mg/kg arsenic in soil in the state of Florida. Soils exceeding 2.1 mg/kg arsenic must be further investigated to determine if there is an environmental risk. However, arsenic has a natural abundance in soil of 6 mg/kg, making this soil screening level overly conservative. Guidelines such as these may decrease the value of "suspect" land that requires "further investigation." Land devaluation results in economic hardship for agricultural producers, homeowners, and public lands in Ohio and elsewhere.

This research addressed an important agricultural and environmental issue: the risk posed to soil ecosystems from the introduction of metals associated with land application of biosolids. OARDC scientists studied the impact of biosolids applied to agricultural soils at the Waterman Farm on The Ohio State University campus in Columbus, Ohio, on plants *(i.e.,* rye grass) and soil invertebrates *(i.e.,* earthworms). The major objective of this research was to evaluate science-relevant, laboratory-derived techniques for assessing the bioavailability of metals and ecotoxicity in agricultural land treated with biosolids.

The metal levels of the biosolids-treated plots at Waterman Farm were well below US EPA Part 503 regulatory limits. However, cadmium (Cd), chromium (Cr), and lead (Pb) levels were found to exceed US EPA EcoSSLs for avian and mammalian ecological receptors, but not for soil invertebrates and plants. This data suggests that although metal levels due to biosolids application to these soils is in compliance with Part 503 regulations, they exceed screening levels for avian and mammalian ecological receptors, suggesting that further assessment of the impacts of metals in agroecosystems receiving biosolids on ecological receptors is warranted.

To this end, future research will focus on the quantification of ecological risk from agricultural land treated with biosolids for soils near or at the US EPA regulatory limits for metals. Biosolids-amended agricultural land that meets this criterion has been identified and will be the focus of a future extramural grant from the research group. Although various measures of metal bioavailability were employed in the study, in order to make meaningful comparisons of these different methods, they must be tested in soils of differing physical and chemical characteristics.

Immunological Mechanism of Probiotic Lactic Acid Bacteria in Prevention and Treatment of Rotavirus Diarrhea in Neonatal Swine

Linda J. Saif and Lijuan Yuan, Food Animal Health Research Program
Ahmed E. Yousef, Food Science and Technology

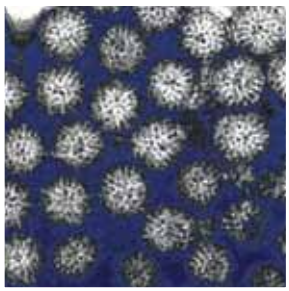
Rotavirus infections in food animals are of major concern to producers, veterinarians, and public health officials. Rotavirus diarrhea is a major cause of economic loss to producers because of costs associated with high morbidity rates, including treatments and reduced performance. Probiotic lactic acid bacteria (LAB) have been tested for prevention of infectious diarrhea associated with bacterial pathogens in suckling and weaned pigs.

The objectives of this research were to define the impact of colonization of the intestine by two LAB strains that are commonly used in the food industry and as probiotics *(Lactobacillus acidophilus* and *L. reuteri)* on development of mucosal immune responses to rotavirus infections, protection against rotavirus diarrhea, and to clarify the immunological mechanisms involved.

In this study, many things were determined. The first was the effects of the LABs *(L. acidophilus* and *L. reuteri)* on rotavirus diarrhea and shedding when given shortly before rotavirus infection of gnotobiotic pigs (sterile pigs kept in germ-free isolators). The LAB feeding did not prevent rotavirus shedding or diarrhea. The lack of protection may be due partly to the short time interval between the first LAB feeding and the inoculation.

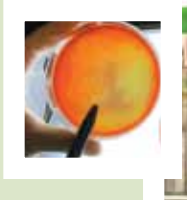
The findings did suggest that although LAB did not prevent rotavirus diarrhea, they may have an adjuvant effect on oral rotavirus vaccines. The single strain *L. acidophilus* NCFM™ significantly enhanced virus-specific T and B cell responses and reduced virus shedding in the vaccinated and LAB-fed pigs compared to the vaccinated pigs without LAB feeding. These results strongly suggest that LAB may be used to improve rotavirus vaccine efficacy. The mixed *L. acidophilus* and *L. reuteri* showed both stimulating and anti-inflammatory, complex regulatory effects on innate cytokine and inflammatory responses in pigs infected with rotavirus. LAB may help to maintain the immunological homeostasis in the gut during rotavirus infection.

Knowledge of the immune mechanisms exerted by probiotics is critical for understanding the functionality, safety, and their possible use as a safe alternative to antibiotics in feeds and/or as vaccine adjuvants. The results from this study offered insights into the mechanisms for the beneficial effects of probiotics and may facilitate development of more effective and safe prophylactic or therapeutic measures and/or vaccines against rotavirus and other enteric diarrheal diseases in pigs and other food animals as well as in humans.



International Grant Competition

The purpose of the International Grant Competition is to stimulate new collaborations between OARDC and food, agricultural, and environmental sciences researchers and scientists in other countries. Collaborating countries provide laboratory space, samples, equipment transport, and technical support and make other contributions to the project.



Development of Rapid and Sensitive PCR Methods for Detection of the Causal Agent of Stolbur Disease on Potato and Integrated Approaches to Its Management

Casey W. Hoy, Entomology
Sally A. Miller, Plant Pathology

Regardless of location, potatoes across the globe are susceptible to a bacterial disease called stolbur. Scientists made use of OARDC science and technology during this study to combat insect-vectored diseases of Ohio vegetable crops and to assist scientists in Turkey with stolbur, a serious problem in northeastern Turkey. OARDC scientists provided advice, training, and consultation on the methodology while our Turkish colleagues conducted most of the research at Atatürk University in Turkey.

Stolbur is also known as witches' broom, because the symptoms include excessive branching in potato stems, and it can cause up to 90 percent loss in the eastern Anatolia region of Turkey, particularly the provinces of Erzerum, Erzincan, and Kars. Despite the seriousness of the problem in this region, little was known about the pathogen or its insect vectors.

All insects feeding on potatoes and all plants growing in potato fields around Erzurum, Turkey, were collected every two weeks for two growing seasons. A total of 561 plant samples representing 14 species and 1,802 insect samples representing 23 species were tested for the pathogen. With assistance from OARDC scientists, collaborators developed a molecular diagnostic method, patterned after the technology developed at OARDC for Ohio plant diseases, that detects the DNA of the pathogen.

The test successfully detected the stolbur pathogen in both plants and insects. The primary vector appears to be a species of leafhopper, *Hyalestes obsoletus,* which completes the nymphal stages on the roots of alfalfa where it acquires the pathogen and then moves to potatoes as an adult. Additional leafhopper species tested positive for the pathogen, but the only alternative plant host for stolbur found in an extensive survey of crop and weed hosts was alfalfa. Given that *Hyalestes obsoletus* nymphs are only found in the soil in alfalfa fields, removal of alfalfa from areas adjacent to potato production is the simplest and most important control strategy that was identified and implemented to solve the disease problem in Turkish potato fields. A potato variety that is relatively tolerant of infection by the stolbur pathogen also was identified for use in areas where the disease is common.

Determination of Optimal Molecular Marker-Assisted Selection Procedures for Improvement of Disease Resistant and Quality Protein Maize Germplasm

Patrick E. Lipps, Plant Pathology
Richard C. Pratt, Horticulture and Crop Science

Corn is the leading feed crop in the United States and the world. It is also a vital source of human nutrition in many developing countries. Corn production in the United States is increasing due to the growing biofuel industry. Production is also expanding in sub-Saharan Africa so that people can be adequately nourished. Corn is susceptible to attack by many foliar pathogens that can reduce its yield and increase its susceptibility to lodging (falling over before harvest).

Gray leaf spot, caused by a fungus that infects the leaves, has been spreading on corn fields since the 1990s in the United States and in Africa. The majority of the hybrids being used by growers in Ohio and Africa are also susceptible to another fungus that infects leaves and causes a disease called northern leaf blight. A new type of northern leaf blight that first appeared in Ohio during the 1980s is becoming more common. Increasing the intensity of corn production (for example, a planting of corn followed by another planting of corn) increases the chances that these diseases could become so severe that farmers are at risk of production loss resulting in higher costs to end users.

Disease resistant germ plasm is needed to help ensure against crop losses because pesticides are expensive and can be detrimental to the environment. Enhanced nutritional content of grain would be an important contribution to the human diet in Africa and would increase the value of feed co-products produced at corn ethanol refineries in Ohio.

This project sought to combine improved disease resistance and nutritional characteristics into corn germ plasm adapted to both the U.S. Corn Belt and African growing conditions. Resistant germ plasm from South Africa was crossed with Corn Belt germ plasm, and then crossed with elite germ plasm from CIMMYT (quality protein maize or QPM, a special kind of corn developed at the International Maize and Wheat Improvement Center and known by its Spanish-language acronym). Controlled testing was then performed for disease resistance using the new race of the northern corn leaf blight (NCLB) fungus in Ohio.

The same lines were also tested in cooperation with scientists in Uganda and Zimbabwe who used the pathogen types found there. This ensured that the best lines would have broad resistance and help prevent breakdown of the resistance. A new molecular technology was used to create molecular markers for the genes controlling the most important traits so that breeders can make faster progress in producing improved varieties for farmers to plant.

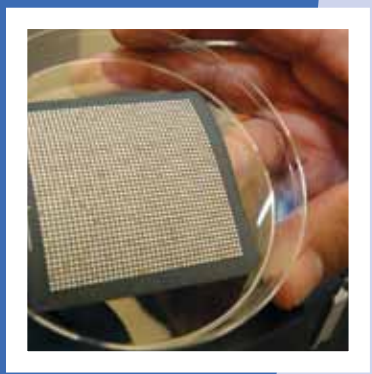
It was found that four of six genes that gave resistance to the three diseases being studied (gray leaf spot, northern leaf blight, and maize streak which occurs only in Africa) could be confirmed and transferred to a breeding population. Molecular markers were then used to help with the identification of the most resistant lines (top 10 percent). Pyramiding (or stacking) the resistance genes into a smaller sub-population by intercrossing the highly resistant lines so that they could be more easily used by breeders was performed. Also crossed were disease-resistant breeding lines with proven Corn Belt lines to test their performance as experimental hybrids under standard field conditions.

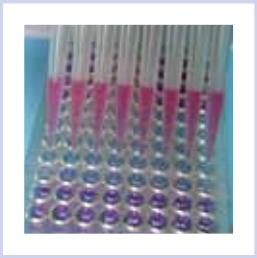
The top-performers were selected for subsequent crossing with Quality Protein Maize (QPM) breeding lines. QPM grain is enriched with the amino acid lysine, an essential building block for producing quality proteins for humans and animals.

Future plans include selecting the breeding lines that display the best field performance, nutritional quality, and disease resistance. These new breeding stocks will help to improve product quality and reduce the risk of corn variety harvest losses caused by diseases.

Seed Grant Competition

The Seed Grant Competition is designed to encourage new and innovative research and to generate the preliminary data needed for successful application to competitive extramural funding sources. Seed Grants are supported at a maximum level of $50,000.





Improving Frost Protection of Ohio Grapes under Controlled Environmental Conditions

Imed Dami, Horticulture and Crop Science

The Ohio grape industry has expanded tremendously in the past 20 years, and the number of wineries has increased exponentially during the last two decades to more than 80 wineries. The economic impact of the grape and wine industry and related tourism is estimated to surpass $100 million in annual revenues to the state. However, the expansion of the grape industry is hindered by climatic threats. Winter freeze and spring frost are common events in continental climates and are the leading causes for crop and revenue losses in vineyards in Ohio.

Several frost protection methods have been tested and have yielded varied success. Although site selection remains the superior approach for frost protection, alternatives have included use of heaters, elaborate sprinkler systems, wind machines, and chemicals. These methods are often expensive, labor intensive, and may cause air pollution. Dormant oils have been used for decades, primarily for insect control in fruit trees. However, researchers found that these oils cause a retardation of bloom and bud break of fruit trees and grapevines, respectively. Unfortunately, the effectiveness of oil was not consistent due in part to seasonal weather variability and time of application.

Scientists sought to improve the efficacy of soybean oil on delaying bud break of grapevines by investigating the optimum time of application in relation to dormancy. Since dormancy is, in part, affected by chilling requirements, it is important to understand the relationship between chilling and oil applications. The specific objectives of this research were to determine the optimum temperature regimes and chilling requirements of two important grape varieties, Concord *(Vitis labrusca* L.) and Cabernet franc *(Vitis vinifera* L.), in Ohio, and also to determine the effect of time of oil application on bud break in relation to dormancy and chilling unit accumulation.

Generally, the number of days to 50 percent budbreak decreased linearly with increased chilling duration in both cultivars. There were differences in chilling requirements between the two varieties, and Concord required more chilling hours at lower temperature than Cabernet franc. Based on results from this study, optimum time of oil application was determined to occur after the required chilling period during the deacclimation stage. Further work is needed to focus on this narrow window of timing and evaluate additional varieties of grapes.

Researchers developed an excellent system for testing chilling requirements under controlled conditions. This research has allowed scientists to discover new findings and raise new questions. The plan for the future is to continue to determine chilling requirements for other varieties. The research focus will be geared toward linking onset of dormancy and chilling requirements to cold acclimation of grape varieties.

Investigations on the Membrane-Bound Progesterone Receptor Expressed by Cells of the Bovine Immune System

Matthew J. Cannon and Joy L. Pate, Animal Sciences

The idea that steroid hormones can regulate the functions of immune cells is common knowledge within the medical community. This knowledge becomes very important when the issue of gender-based differences in disease prevalence is considered, such as the greater frequency of autoimmune diseases in females than in males. For successful reproduction in mammals, the immune system must be regulated so that the fetus, which is considered foreign to the maternal immune system, is not rejected. However, very little is known about the mechanisms by which the reproductive system and the immune system communicate.

During this study scientists developed a model to study interactions between steroid-producing ovarian cells and lymphocytes. Using this model, researchers demonstrated that progesterone, the steroid hormone responsible for the maintenance of pregnancy, inhibits the ability of the ovarian cells to activate the T lymphocytes. Steroids typically act on cells by binding to receptors that are found within the cytoplasm or the nucleus of cells; however, lymphocytes obtained from the blood of cows did not express the cytoplasmic/nuclear receptor. Very recently, the presence of a novel, membrane-bound progesterone receptor was described.

The objectives of the present study were to determine whether bovine lymphocytes express membrane progesterone receptors (mPRs), to study the regulation of these receptors, and to analyze their expression in the different T lymphocyte subpopulations.

To determine whether membrane progesterone receptors were expressed, bovine peripheral blood mononuclear cells were isolated from whole blood of cows at different stages (days 3, 11, and 19) of the estrous cycle. The T lymphocytes were separated from peripheral blood mononuclear cells and either placed in culture with steroid hormones or frozen for analysis of mRNA.

As a result of this research, scientists discovered that peripheral blood T lymphocytes express the genes that encode all known forms of membrane progesterone receptors. Therefore, it is believed that progesterone regulates the activity and function of T lymphocytes through membrane receptors. The manner in which progesterone signals the cells via membrane receptors is not known and will be the subject of future studies.

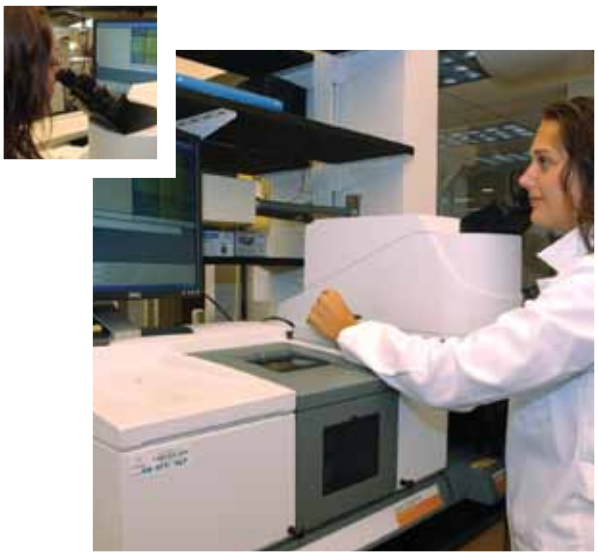
Ongoing research of this subject is essential as understanding how steroids act on immune cells could lead to better ways to enhance or control reproduction in farm animals as well as in humans. This knowledge could also be used within another branch of the medical world to possibly define new ways to prevent or treat various autoimmune diseases.

Rapid and High Throughput Detection of Pathogenic Bacteria in Food Samples

Luis Rodriguez-Saona, Food Science and Technology

Despite strict regulations and new technologies in the food industry, foodborne illnesses remain a major challenge for producers and consumers alike. In the United States alone, there are 5,000 deaths per year as a result of contaminated foods. People most affected by disease-causing bacteria in foods are infants, those who are pregnant, those who have immuno-compromised systems, and the elderly. In addition to the well being of people, the economic impact is also quite large: For instance, in a single year, salmonellosis (nausea, diarrhea, vomiting caused by *Salmonella*) resulted in production losses costing $500 million to $2,500 million.

Rapid, easy-to-use, and cost-effective techniques for the food industry and regulatory agencies are needed for effective microbial surveillance to ensure food safety. Traditional methods for the detection of disease-causing bacteria are accurate and low cost; however, they often consist of several long procedures, require trained personnel, and take as long as three to six days. This time span is too long, considering that foods are shipped from companies every day, and it may take only hours or a few days to develop a disease from consuming contaminated food. The goal of this project was to develop a tool that would assist in efforts to prevent contaminated food from reaching consumers.



In an effort to achieve the project goal, OARDC scientists have developed a protocol to isolate and identify foodborne pathogenic bacteria, specifically *Salmonella enterica* serovars, from foods by using immunomagnetic separation and infrared spectroscopy. Immunomagnetic separation (IMS) is a method that utilizes micro-sized magnetic beads coated with antibodies against a chosen bacterial species. The beads are easily dispersed in solution and manipulated under the influence of a magnetic field, which facilitates efficient bacterial retrieval and concentration. The affinity-captured bacteria are analyzed by infrared spectroscopy which provides fingerprint information on the biochemical composition of the samples that are used for the identification and sub-typing of bacterial species. This procedure takes just about 24 hours, a considerable reduction in testing time.

To accomplish the goal of this study, saline solutions were contaminated with a known level of bacteria. Dynabeads® anti-*Salmonella* were added to the contaminated solution to specifically separate and concentrate the pathogenic *Salmonella* bacteria. The data were analyzed statistically by pattern recognition analysis that allows the generation of classification models to help visualization of clustering among samples by using score plots and model misclassification tests. The classification models provide information to determine important spectral bands and to generate prediction models for analysis of unknown species.

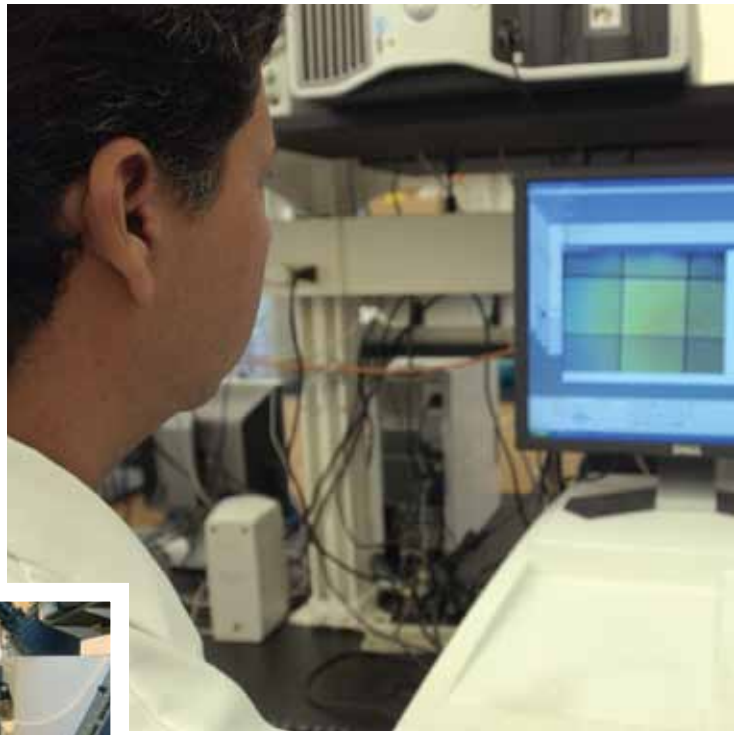
The classification model correctly predicted the presence of *Salmonella* bacteria in solution after they were separated using the immunomagnetic beads. Not only was the model able to predict whether or not *Salmonella* bacteria were present on the beads, it was also able to predict specifically which strain was present, once the beads were removed from the cells. At this point the procedure took a little over 24 hours. Approximately one million cells were needed.

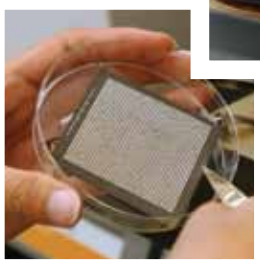
In order to improve the method further, scientists switched to an infrared microscope, which has a better detection limit, meaning it needs the biomass of only about 1,000 to 10,000 cells in order to give accurate spectral information. Using this method, the bacteria captured by the beads were plated onto standard plate count agar. After only eight to 10 hours,

enough bacteria were present to allow for building a model and making predictions, without requiring a removal of the beads from the bacteria.

The next step for this protocol will be testing the presence of foodborne pathogens in actual foods, such as apple, orange, or tomato juice; eggs; meats; and milk. For improved detecting ability, the library of bacteria could be expanded; that is, the same experiment could be carried out using some of the other strains of *Salmonella* currently known to cause disease. Furthermore, this method has the potential to be used for the detection of other pathogens, since immunomagnetic beads are also available for *Listeria monocytogenes* and *Escherichia coli* O157:H7, the pathogen responsible for the recent outbreak of food-related disease from spinach.

In conclusion, combining Fourier transform infrared spectroscopy and immunomagnetic beads with multivariate analysis isolated and differentiated specific *Salmonella* strains. The method is rapid and simple to perform and requires minimal sample preparation. Due to the specificity of the spectra to the organisms, false-positives (tests that indicate contamination, even when there is none) are eliminated, and differentiation between harmless bacteria and pathogens is simpler. Ultimately, this technique will contribute to more effective and efficient detection techniques for processed foods with regard to contamination by pathogenic microorganisms. This, in turn, minimizes production loss, and therefore cost, while enhancing consumer safety.





Mapping Ash Tree Distributions and Emerald Ash Borer Infestations by Remote Sensing

Daniel A. Herms, Casey W. Hoy, and Prasad Vadrevu Krishna, Entomology

Emerald ash borer (EAB) — *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae) — is an invasive beetle species from Asia that has caused extensive mortality of ash trees *(Fraxinus* spp.) since arriving in the United States in 2002. The first reported infestations in Ohio were in February of 2003. EAB infestations were targeted at common species of native ash trees — green ash *(Fraxinus pennsylvannica),* black ash *(F. nigra),* and white ash *(F. americana).* EAB adults are dark metallic green, 1/2 inch in length and 1/8 inch wide, and fly only from mid-May to September. Larvae spend the rest of the year developing beneath the bark. EAB larvae consume inner bark and outer sapwood (cambium) of ash trees. Owing to the important role of the cambium in vital nutrient transport functions, a tree will usually die within three to five years of infestation.

EAB has destroyed nearly 20 million trees in five states or about $10 billion worth of trees based solely on tree removal costs and at least $20 billion to replace them with smaller diameter trees. Tree replacement costs in Ohio communities, including streets, parks, and private properties, are estimated in the range of $0.3 to $1.3 billion.

Monitoring of EAB and its rapid spread has been difficult. In particular, visual identification of recently infested ash trees from EAB is problematic when external symptoms such as adult exit holes, callused galleries, bark splits, and canopy dieback are not visible. Determining whether such trees are infested requires cutting them down and removing the bark. Nondestructive methods using improved remote sensing methodologies are urgently needed to identify early emerald ash borer infestations, especially on the perimeter of the infestation, to further undertake rapid and effective mitigation strategies.

Satellite remote-sensing technology has been extensively used in forestry, agriculture, urban planning, disaster mitigation and monitoring, hydrology, and meteorology studies, etc. More specific examples in forestry are forest inventory mapping; forest fire detection; identifying forest trees affected due to pest damages *(i.e.,* gypsy moth infestations); deforestation and logging activities; and estimating net primary productivity and carbon sink from forests.

The goal of this project was to develop remote sensing methodologies for ash and EAB infestation mapping, which are needed for research to support EAB assessment and eradication. Scientists hypothesized that remote-sensing technology with its multi-temporal, multi-spectral synoptic and repetitive coverage would help in effective mapping of ash trees and EAB infestation in heterogeneous landscapes. Such detection methodology would lead to considerable cost savings by efficiently targeting efforts in the tree-removal

eradication program, associated ground surveys, and trapping efforts. Also, detecting both ash and infested ash can provide valuable research on the population dynamics, spread, and risk of spread of this pest.

For this study, scientists used vegetation indices derived from both LANDSAT and QUICKBIRD satellite data for quantifying signature differences in healthy ash as well as EAB-infested ash. Vegetation indices from these two satellite data sets were explored to identify the best indices useful for classification purposes. In addition, authors used computer-aided regression trees algorithm for classifying different levels of EAB infestation. Computer-aided regression trees algorithm is a nonparametric procedure that uses a stepwise method to establish splitting rules and provide the final binary tree product of indicator variables, useful for delineating different classes.

After thorough evaluation, scientists found that QUICKBIRD data is more suitable than LANDSAT data due to spatial resolution. For the purpose of classification, QUICKBIRD data was used. Most importantly, relating to accuracy, the QUICKBIRD image that is purchased from DigitalGlobe, Inc. (Longmont, Colorado) is radio-metrically and geometrically corrected. It has been further rectified to the world geodetic survey 1984 datum and the Universal Transverse Mercator coordinate system. The pre-rectified standard imagery had an average absolute positional error of 23 m and a root mean square error of 14 m. To improve the positional accuracy, the pre-rectified imagery was further rectified based on a set of ground control points collected from the imaging area with a global positioning system. The root mean square error of the re-rectified imagery was reduced to approximately 5 m (after ground truth).

For identifying the ash trees and infested ash trees on the QUICKBIRD imagery, extensive ground truth information was collected using GPS surveys. Since the QUICKBIRD data resolution is relatively high, the GPS-sampled point locations of ash trees could be easily overlaid on the satellite imagery for further analysis. Once overlaid, the signatures from QUICKBIRD data in the visible channel were extracted and further used in classification. A decision tree was obtained with six terminal nodes, and the computer-aided regression trees algorithm identified three important vegetation indices out of 17 and one textural measure. Of the several vegetation indices, Green Normalized Difference Vegetation Index, Atmospherically Resistant Vegetation Index, and Non-linear Vegetation Index were found to be highly useful for discerning ash trees and EAB-infested ash. The imagery selected is quite accurate and is also supported well by the extensive ground truth points.

Overall, results identified the potentials and limitations of satellite remote sensing data in detecting ash trees and EAB infestation. Of the two different sensors, LANDSAT and QUICKBIRD, results from the latter were quite promising. It is inferred that data can be effectively used for ash tree detections and EAB-infested ash trees. Results were based on extensive ground truth information on ash trees and EAB-induced ash mortality in the study area. The QUICKBIRD imagery as well as the GIS-based database assembled for the project period for watershed boundaries, road networks, soils, vegetation, and land use has been used for the development of other research proposals, including studies on invasive species. The database has also been made readily available for sharing with other researchers.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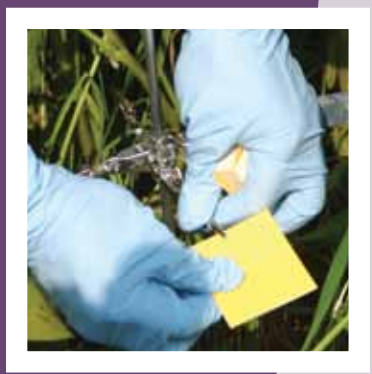
Industry Small and Matching Grant Competitions

The Industry Small and Matching Grant Competitions are specifically designed to develop partnerships with private industry and nonprofit foundations. Industry Small Grants provide up to $6,000 from the SEEDS program, while Matching Grants provide up to $50,000. Investigators are required to obtain at least a dollar-for-dollar match from industry for both of these competitions.



Developing Organic High-Oil Hull-Less Oats in Ohio

Deborah H. Stinner, Entomology

From an ecological and environmental standpoint, small grains like oats play important roles in agroecosystems. While many conventional grain farmers use only corn and soybeans in rotation, small grains are used in organic rotations. They break up the intense tillage needed to produce row crops organically. Typically inter-seeded with row crops and followed by a leguminous hay crop, these parts of organic rotations are important for restoring and building soil quality in organic farming systems. Furthermore, spring-planted small grains, such as oats, provide valuable management flexibility for organic farmers when used in combination with fall-planted small grains. Unfortunately, economic returns on traditional organic small grains, especially oats, are lower than other organic crops. However, high-oil hull-less oats receive a price several times higher than regular oats. Ohio's typical cool wet springs provide ideal growing conditions for high-oil oats.

The long-term goal of this work is to build capacity in Ohio for production and processing of high-quality organic oat oil which is used in cosmetics as well as food. The short-term goal of this specific project was to evaluate the suitability of organically raised high-oil hull-less oats for a patented equine nutraceutical.

The feasibility of using oats as an oilseed crop depends on the availability of oat cultivars with high groat oil content and acceptable agronomic performance. Over the course of this project, two cultivars of high-oil hull-less oats were studied under different growing conditions.

In 2003, a proprietary line of high-oil hull-less oats was grown, and there was good success under organic conditions. The protein, fat content, and overall chemical profile were considered to be of high quality. Collaborators conducted a feeding trial on horses with their patented equine nutraceutical made from the organic high-oil oats to investigate the effects of the high-oil hull-less oats on serum chemistry and complete blood counts of horses. Results showed that the high-oil oats were safe and had a highly desirable fatty-acid profile when compared to a low-fat diet. However, additional research is needed to fully evaluate the potential benefits of high-oil oats as an equine feed source.

In 2004, seed from the 2003 crop was used in an experiment that was designed to evaluate the effect of six different fertility amendments (three composts, raw manure, chemical fertilizer, and a control) on oat protein, beta-glucan, and lipid content. The different treatments appeared to have no effect on oat chemistry.

In 2005, the variety being used became unavailable. Although another variety, Paul, from North Dakota was identified, the planting failed. In 2006, the Paul variety was planted again, and the soil amendment experiment that was conducted with the variety used in 2004 was repeated. Again, the overall chemistry was acceptable, and no significant treatment effect of the different amendments on crude fat content of the oats was noted. Several bushels of the 2006 crop were evaluated by equine athlete owners in northeastern Ohio, and they provided positive feedback.

A continuing collaboration is ongoing with the focus on building a larger supply of seed. A collaboration with local organic farmers who will grow the high-oil hull-less oats in 2008 is being developed. Work with the horse industry is ongoing, and planning for the development of an oil extraction plant in Ohio is being pursued.

Building Capacity for High-Quality Organic Spelt Production for Local and Regional Spelt Producers

Deborah H. Stinner, Entomology

Spelt is an important crop for many organic farmers in Ohio and nationally. About a third of all U.S. spelt is grown on certified organic land, and Ohio is one of the leading producers. An ancient grain, with archaeological evidence dating to 4700 BC, spelt is classified by botanists as a subspecies of bread wheat. Spelt has developed a profitable lore in the health food marketplace that goes back some 800 years in Europe with St. Hildegard von Bingen, German scholar, poet, dramatist, physician, and political moralist, who wrote: *"The spelt is the best of grains. It is rich and nourishing and milder than other grain. It produces a strong body and healthy blood to those who eat it and it makes the spirit of man light and cheerful."*

There is a perception in the natural foods marketplace that spelt may be safe for many people with wheat allergies. Because a few varieties of spelt may contain some wheat genetics, it is absolutely necessary for spelt processors to know the genetic composition and resulting chemical profiles of the various spelt varieties.

While the spelt market has been quite good for organic farmers in the past, supply and demand dynamics and quality issues have lowered prices in the last few years. The long-term goal of this work is to build capacity and enhance production of high-quality spelt in Ohio for local and regional processors who have national prominence in the spelt niche market.

Ohio is home to one of the largest spelt bread producers in the United States, a producer who was one of the industry partners on this project. Currently, the spelt used for the award-winning breads produced by this partner is being purchased in Europe. A second industry partner, the largest spelt buyer in the United States and one who produces a diverse range of high-quality spelt pasta and snack food products, also supported this research. Both partners have a desire to develop a grower base that can provide high-quality organic spelt in Ohio and the region.

The main objective of this project focused on spelt varieties and production practices that will consistently produce a high-quality organic spelt while providing an important economic opportunity for local growers. To that end, a variety experiment was conducted in 2004 with three spelt varieties to evaluate quality and production differences. The intent was to send a sufficient sample of each variety to the bread-producing partner for baking evaluations. However, an unexpected limitation with respect to getting the grain de-hulled was encountered. In contrast to wheat, spelt hulls remain in contact with the grain during harvest, and therefore spelt must be dehulled before milling. The samples were not large enough to be commercially de-hulled, and no small dehuller was identified for this research.

To address inconsistent quality, an experiment was conducted using one ton per acre of poultry compost/manure product, an approved commercial organic fertility amendment, as a top dressing. This treatment was explored since most organic farmers do not fertilize spelt either at planting or as a top-dress operation. A quantity of one spelt variety was produced and sent to the second industry partner. Quality assessments by the industry partner were positive, with most parameters being good enough for price premiums. An attempt to replicate the variety experiment in 2006 did not meet with success because of winter damage.

Future organic spelt research will focus on field trials for several years and refining the top-dressing management regime by investigating different organically approved fertility products and rates to determine how to optimize profit return to farmers and quality grain for the processors. In addition, interdisciplinary collaborations with researchers in the Ohio State University Department of Food Science and Technology are planned and will include nutritional analysis as well as baking evaluations.

Evaluation of Strobilurin Fungicides for Use in a Disease-Forecasting System for Strawberry Leather Rot Caused by *Phytophthora cactorum*

Michael A. Ellis, Plant Pathology

Leather rot has wreaked havoc on strawberry crops in Ohio during wet growing seasons for decades. This economically devastating disease is caused by a bacterium known as *Phytophthora cactorum*. Leather rot represents an extremely serious threat to strawberry production in strawberry-growing areas of the United States. Currently, fungicides are an important component of the disease-management program. Ridomil Gold™, phosphorous acid (also known as Agri Fos™), and the strobilurin fungicides (Abound™ and Cabrio™) are the standard fungicides registered for the control of leather rot.

All of these fungicides are currently used in protectant spray programs; therefore, they are applied as prophylactic treatments regardless of whether actual infection periods have occurred. In such programs, many of the applications that are currently made are probably not required. The unnecessary applications result in increased costs to growers and needless deposition of fungicide in the environment. The application of curative fungicides in response to predicted infection periods ensures that fungicides are applied only when required, which generally results in a reduced number of applications, improved disease control, and reduced costs to growers.

A disease predictive model for leather rot was developed in Ohio. Due to the lack of fungicides with "after infection" or curative activity, the predictive system has not been implemented. All of the fungicides previously mentioned have some degree of systemic movement in plant tissues. However, their movement into strawberry fruit tissues and their potential curative activity has not been studied.

During this study, researchers determined the curative activity of Ridomil Gold™, potassium phosphate, Abound™, and Cabrio™ for control of strawberry leather rot. Scientists also evaluated these fungicides for post-infection disease control in the field using the disease predictive model for leather rot. The ultimate objective is to further develop and validate the disease predictive system for strawberry leather rot in Ohio.

During the study it was found that all fungicides tested provided excellent protectant activity against leather rot for up to seven days, but the strobilurin fungicides azoxystrobin and pyraclostrobin had weak post-infection activity.

During two years of field testing, mefenoxam and phosphite both provided excellent leather rot control when applied in response to flooding events (predicted infection periods). Their use in a curative program resulted in fewer fungicide applications than a calendar-based protectant program with an equal level of control.

The curative activity of these fungicides could also be of great benefit to growers even in the absence of disease predictive systems. For example, if a grower encounters heavy rainfall, especially when flooding events occur, the application of these materials within 36 hours of the start of the rain event could aid in preventing a leather rot epidemic.

Further studies will be conducted using the disease predictive model for leather rot to evaluate the post-infection activity of mefenoxam and phosphate in the field.

Potential for Airborne Spore Dispersal by the Pathogen Causing Microdochium Blight of Pumpkin

Robert J. Precheur, Horticulture and Crop Science
Landon H. Rhodes and Richard Riedel, Plant Pathology

Microdochium blight (also known as Plectosporium blight or "white speck") is a fungal disease of pumpkin and other cucurbits that presents a serious threat to production of vine crops throughout Ohio. The disease often appears suddenly and rapidly defoliates vines and disfigures fruit. The fungus that causes this disease is known to produce large amounts of asexual spores on the surface of infected leaves, stems, and fruit. These spores are dispersed primarily by water-splash and travel only a few inches to a few feet. However, the disease sometimes appears suddenly in a field in which it has never before been observed. This rapid appearance of the disease and the fact that symptoms occur uniformly throughout the field suggest that the fungus reaches plants by means of airborne spores from outside the field.

This research was conducted to determine if airborne spores were produced by isolates of the fungus found in cucurbit fields, and, if so, whether they contribute significantly to disease development. If airborne spores are found to be a significant component of the total inoculum load in a field, programs for disease control, including such aspects as crop rotation and fungicide spray programs, would need to be timed to coincide with periods of airborne release, thus protecting plants from early infection.

The objective of this study was to determine if strains of the Microdochium blight pathogen from Ohio pumpkin fields are capable of producing an airborne spore stage, which would account for the sudden and severe appearance of the disease in individual fields. Knowledge of the existence of an airborne stage of this pathogen could lead to a better understanding of how this fungus first becomes established in a pumpkin field and could enable growers to time fungicide applications to coincide with periods of airborne spore release. Accordingly, isolates of the Microdochium blight pathogen were collected from pumpkin fields throughout Ohio. Isolates of the pathogen were grown alone and in pairings with other isolates to determine their ability to produce fruiting bodies that give rise to airborne spores.

Foliar and fruit samples were collected from pumpkin (and other cucurbit) fields throughout Ohio. Samples showing symptoms of Microdochium blight were cultured for pathogens using standard laboratory isolation techniques. To date, 14 isolates of the pathogen have been obtained. Isolates have been grown alone and in combination with other isolates and observed over a period of five to six weeks for the presence of the fruiting bodies, which give rise to airborne spores. One isolate from gourd produced immature fruiting bodies in pure culture, but the fruiting bodies did not mature, and spores were not produced. It is likely that nutritional or environmental conditions may not have been optimal for fruiting body formation. Another possibility is that opposite mating types are necessary for the production of mature sexual fruiting bodies with airborne spores.

In order to make appropriate recommendations to producers for fungicide application and other control methods, continued research will focus on determining the necessary conditions and/or mating types needed for fruiting bodies.

Effective Application of Fungicides to Control Asian Soybean Rust in Ohio

Erdal Ozkan, Food, Agricultural, and Biological Engineering

Soybean yield loss due to Asian soybean rust varies from negligible to complete loss of crop, depending on many factors including severity of the disease outbreak, timing of infection, selection of fungicides, and their timely application using the most effective equipment. Even if rust causes a modest 20 percent yield loss in Ohio's 4.5 million acres of soybeans, the total income lost by soybean growers in Ohio could reach $270 million.

Chemicals manufactured to control soybean rust are effective. However, successful and efficient control of soybean rust depends on proper application of these chemicals. The single most important factor affecting the control of soybean rust is to get thorough coverage of the plant with chemicals. Unfortunately, the labels on these chemicals fail to clearly state the type of application equipment and/or setup that provides the most effective coverage. The chemical manufacturers are reluctant to give specific spraying recommendations because reliable research data is lacking in this area. Since there are no established guidelines on application of fungicides for rust, soybean growers in Ohio are frustrated with all the different recommendations coming from different sources. To solve this problem, researchers conducted field experiments to determine the most effective spray equipment for applying appropriate chemicals to soybeans to control Asian soybean rust in Ohio.

Questions that are frequently asked by the soybean growers — what is the best nozzle type (cone, flat-fan, low-drift, etc.); what is the best droplet size range; best spray pressure; nozzle set up (directed, twin pattern, single nozzle); sprayer setup (conventional, air-assisted, electrostatic, etc.); travel speed and carrier application rate — were addressed in this study.

Results from this study provided a clear set of recommendations that, if followed, may lead to eliminating losses that have the potential to reach into the hundreds of millions of dollars. First, when using conventional sprayers, a nozzle/equipment set up that provides medium spray quality (rather than fine or coarse) tends to provide a better penetration of droplets inside the canopy and better coverage. Spray hitting the target from two different angles (as in the case of TwinJet nozzles) produces better coverage if the canopy is not dense. But, in dense canopy conditions, flat-fan nozzles with a single spray pattern producing medium quality spray provide a better penetration of droplets inside the canopy.

An air-assisted sprayer did a better job with penetration of droplets into the canopy and spray coverage than a conventional sprayer. By mechanically opening the canopy with a well-designed mechanical canopy opener, conventional boom sprayers may provide coverage and penetration nearly as good as that from air-assisted sprayers. However, the canopy opener will not be effective in reducing drift, which is another benefit achieved from using air-assisted sprayers. At 15 gallons per acre and 7 mph, and under dense canopy conditions, flat fan nozzles provided better coverage and penetration into the canopy than the hollow cone nozzle.

The findings of this study have been presented at professional meetings and published in journals. However, it is important that the new spray recommendations reach producers and to that end, an Ohio State University Extension fact sheet is being developed.

Integrating Powdery Mildew Tolerance and Fungicide Disease Control Programs to Maximize Economic Return for Pumpkin Production

James R. Jasinski, Ohio State University Extension
Robert J. Precheur, Horticulture and Crop Science

Ohio is No. 1 in the country for production of pumpkin crops, and powdery mildew is a huge problem for producers. Since powdery mildew thrives in humid climates, it often appears during the warm July months of Ohio's summers.

Symptoms of powdery mildew include small colonies composed of fine white thread spreading across upper surfaces of infected leaves on pumpkin vines. These colonies coalesce and eventually cover stems and foliage with white, powdery masses of spores. In severe cases, leaves will yellow and die. Loss of leaves and other foliage hastens maturity of fruit and increases sunburning. Stems infected with powdery mildew become brown. The brown stems are less aesthetically pleasing and desirable on pumpkins, which lowers the value of the overall crop.

The objectives of this study were to compare the impact of a Powdery Mildew Resistant (PMR) variety, a standard or susceptible variety, and four fungicide disease-control treatment programs (low cost, grower standard, highly intense, and Quintec) on powdery mildew development and pumpkin fruit yield and quality. Standard variety Pro Gold 510 and PMR variety Super Herc were each treated with four different fungicide programs.

When the powdery mildew development on the foliage was first observed, there was very little development on the upper surfaces of the leaves regardless of variety or fungicide program. However, Pro Gold with fungicide treatment 3 had significantly more powdery mildew development than Pro Gold fungicide treatment 1 and Super Herc with fungicide treatments 3 and 4. On the lower leaf surface, Super Herc with all fungicide treatments and Pro Gold with fungicide treatment 4 had significantly lower powdery mildew development, less than 6 percent leaf coverage, than all other Pro Gold fungicide treatment combinations. In the Pro Gold fungicide treatment combinations 1, 2, and 3, powdery mildew leaf coverage was greater than 40 percent.

Use of a suitable PMR variety can significantly reduce powdery mildew development regardless of fungicide treatment. Pro Gold with fungicide treatment 2 produced significantly greater tons per acre than Pro Gold and Super Herc with fungicide treatment 1. There were no other significant yield differences among variety and fungicide program combinations. Pumpkin marketable fruit number per acre produced is more a reflection of variety with Pro Gold producing more fruit number per acre than Super Herc. There were no significant differences in fruit number per acre among fungicide treatments within a variety.

Differences in average fruit size between Pro Gold and Super Herc are influenced by variety; however, Pro Gold treated with the low-cost fungicide program had significantly smaller fruit than other Pro Gold fungicide treatments. Presence or absence of powdery mildew on handles was not significantly different among varieties or fungicide treatments.

Overall, the low-cost fungicide program allows for greater powdery mildew development on the undersides of the leaves, less marketable fruit number per acre, and potentially smaller fruit size. The standard grower fungicide program provides good yield and fruit quality, and the selection of a PMR variety can enhance yield. A more intense fungicide program did not significantly improve fruit yield or quality. Quintec alone was equal in yield and quality to the standard grower program. Demonstrations of various fungicide programs for growers are planned for future workshops.

Field Evaluation of Microdochium-Resistant Pumpkins

Robert J. Precheur, Horticulture and Crop Science
Landon H. Rhodes, Plant Pathology

Microdochium blight (also known as Plectosporium blight or white speck) is a fungal disease of pumpkin, gourd, squash, and other cucurbits that has caused severe losses in Ohio. When Microdochium blight develops under optimal conditions of warm, wet weather, the disease is extremely damaging. The fungus initially causes superficial lesions on veins on the underside of leaves, then quickly spreads to leaf blades, petioles, stems, and developing fruit. It defoliates the plant and causes cracking and death of infected stems.

Because the fungus causes disfiguring lesions on the fruit of pumpkin, gourds, and other vine crops, affected plants may have no marketable fruit. Even a low incidence of the disease can have substantial economic impact. Control of Microdochium blight at this time requires both long rotations and additional fungicide sprays in the spring before normal spray schedules would start in late July. Both of these practices increase production costs for Ohio growers.

The best control for this disease is to plant pumpkin varieties with high levels of resistance. These varieties should also have acceptable horticultural characteristics, such as good color, shape, and handle thickness. No such varieties are known to exist now, but if found, these varieties could be used immediately for commercial production or could be used by plant breeders to develop improved varieties for Ohio growers.

In previous work funded by the Ohio Vegetable and Small Fruit Research and Development Program and OARDC, scientists developed a greenhouse procedure to screen pumpkins for resistance to Microdochium blight. During 2004 and 2005, researchers evaluated resistance in pumpkin plant introductions (PIs) from the worldwide pumpkin germ plasm collection maintained by the National Plant Germ plasm System. Nearly all the PIs tested were highly susceptible to Microdochium blight.

However, at least four PIs appeared to have relatively high levels of resistance to the disease. Two of these four PIs were from Zimbabwe and two were from India. These PIs have potential to be used as parents in developing commercial varieties of pumpkin with Microdochium blight resistance. Although these PIs have shown resistance under greenhouse conditions, it was not known if they would continue to appear resistant under field conditions, especially in sites with high inoculum potential and in environments favorable for disease development.

Further, the horticultural characteristics of these PIs, particularly the size, shape, and color of the fruit, were not adequately known. For these reasons, it was important to establish a field trial in a site with a high level of disease pressure in order to make comparisons with a current commercial variety as well as horticulturally comparable but disease-susceptible PIs.

The objectives of this study, therefore, were to evaluate Microdochium blight severity in pumpkin varieties (plant introductions) previously classed as resistant or susceptible based on greenhouse tests and to evaluate the horticultural characteristics of varieties with Microdochium blight resistance in order to determine their suitability for Ohio growers.

Field plots were established in June 2006 at the Western Agricultural Research Station, located in South Charleston, Ohio, with 11 entries. The pumpkin variety Pro Gold 510 (susceptible) was used as a standard commercial check. Plots consisted of single 40 foot rows of pumpkins transplanted 3 feet apart in rows 15 feet apart. Each variety was replicated four times. Foliar disease severity was assessed in late July and mid-August by estimating the percent of petiole or leaf area covered with lesions in each plot. Final foliar blight ratings and fruit lesion severity ratings were made on all foliage and fruit in each plot in October.

Symptoms of white speck were obvious by mid July. By late July, 50 to 80 percent of petiole surfaces and 50 to almost 70 percent of leaf blade surfaces were covered with lesions in the susceptible PIs 'Omaha Pumpkin,' 'Yellow Oval,' and the commercial check variety Pro Gold 510, while in five resistant PIs, foliar disease was below 6 percent. White speck severity was intermediate for 'Little Gem.' Similar results were seen in mid August, with 'Yellow Oval' disease severity approaching 90 percent for both petioles and leaf blades, while resistant PIs were below 7 percent.

By October 11 foliage in the susceptible varieties was almost totally destroyed by Microdochium blight, while resistant PIs generally had healthy foliage. Fruit scarring was most obvious on Pro Gold 510. Results indicate that resistance to Microdochium blight exists in certain plant introductions, and that greenhouse tests for Microdochium blight severity accurately predicted disease severity in the field.

While these results are promising, it should be noted that all PIs with Microdochium blight resistance had colors and shapes that were generally not acceptable for 'Jack O'Lantern'-type pumpkins. Therefore, further experiments are planned to evaluate varieties and hybrids that have similar levels of Microdochium blight resistance but also have more commercially acceptable horticultural characteristics.

Characterizing *Pythium* Populations from Corn and Soybean Fields in Ohio

Anne E. Dorrance, Plant Pathology

Corn and soybean seedling blight has repeatedly caused significant stand reduction in certain Ohio fields. Seedling blight is primarily caused by the water molds, *Pythium* species, which are found in the soil. These species can kill some seedlings before or just after germination, but often plants will survive initial infection. Non-lethal wounds caused by these pathogens may lead to reduced root and shoot growth, resulting in reduced plant vigor and yield, especially under periods of stress conditions. Some of this problem may be due to a recent shift in planting dates or in some cases new fungicide seed treatments. Earlier planting means seeds are more likely to be placed under environmental conditions unfavorable for rapid germination, thus increasing the level of stress on the seed.

When seedling blight is present at high levels in a field, the field must be replanted. This adds an additional cost of seed/planting and often decreased yield due to the later planting. For soybeans, the cost of replanting is an additional $80 per acre while for corn, the seed alone is $200 per acre. Thus, managing these early-season diseases is critical to successful early stand establishment.

The primary benefits of characterizing the *Pythium* species will be to producers first, but also seed and fungicide companies as they tailor products to the Ohio landscape.

The most common management strategy for early season seedling disease caused by *Pythium* is the use of fungicide seed treatments. An earlier study found that mefenoxam and azoxystrobin were effective against several species of *Pythium,* but neither were able to control all species of *Pythium* in Ohio. Captan, although no longer available for many seed treatment formulations, provided good control for most species of *Pythium,* and growth of all species was decreased by at least 80 percent. Of all the fungicides evaluated, none was able to equally inhibit all species of *Pythium.* The combination of harsh environmental factors and limited efficacy for some *Pythium* spp. has contributed to the increased occurrence of emergence problems recently experienced by growers in both corn and soybean fields.

Corn and soybeans are produced annually on eight to nine million acres encompassing at least 11 different soil types, most of which are poorly drained. To determine where *Pythium* species are distributed across the different soil regions in Ohio, a high-throughput and accurate identification process needs to be developed to enable analysis of a greater number of locations.

Due to the diversity of Ohio's agronomic crop production regions, an accurate screening method to assess pathogen diversity was required. For some organisms, some regions of the genome can be used in identification. Many copies of this region are made from the DNA of an organism through a process called polymerase chain reaction (PCR). Typically, for many molecular studies, DNA extraction or sample pretreatment is required first; this takes time and can be costly. OARDC scientists assessed a technique called Direct Colony Polymerase Chain Reaction or DC-PCR which is more ideal to use with environmental samples. DC-PCR combines the DNA isolation step and the PCR step.

Using this technique, researchers amplified the genomic region used for identification. From the amplified DNA, a second technique called Single Strand Conformational

Polymorphism (SSCP) was implemented. SSCP is a commonly used mutation detection procedure. Single strand DNA molecules fold into complex 3-D structures as a result of intra-strand base pairing. These can vary considerably and can be visualized on an electrophoresis gel.

For this study, the baiting procedure was able to recover multiple pathogens of soybean and corn from all locations permitting scientists to recover previously unreported *Pythium* species. This method, direct colony PCR, allows for the omission of the timely step of DNA extraction, and once isolates are in pure culture, they can be used for PCR. The SSCP procedure using the MEGA-GEL apparatus is able to evaluate the banding patterns of 192 isolates at once. This is sufficient for the evaluation of two to three locations at one time. The banding patterns of the 18 different species of *Pythium* previously recovered from soil in Ohio are distinct from one another and are consistent between gels. At this point, all of the 80 fields have been sampled, and 33 locations have been assayed with a total of 2,475 *Pythium* isolates collected. Currently the mean number of isolates per location is 75.

Researchers will continue to assess the diversity of the *Pythium* species in Ohio using this high-throughput procedure. The *Pythium* species that are recovered, including new species, will be characterized for pathogenicity, sensitivity to new fungicides, and the baseline resistance of modern corn hybrids and soybean cultivars. This is the first step in the development of new more effective management strategies for Ohio agronomic crop producers to limit losses from *Pythium* species in Ohio.

Use of Abscisic Acid (ABA) and Polyethylene Glycol 8000 (PEG 8000) to Control Vegetable Transplant Height

Mark A. Bennett, Horticulture and Crop Science

Vegetable transplants can become tall and leggy prior to field establishment, producing challenges for growers using mechanical transplanters to establish their crops. Tall and leggy plants have thinner stems and are more prone to wind damage after planting them in the field. They often require additional labor to hand plant if they are too tall to use a mechanical transplanter. Preliminary greenhouse research in 2005 showed that the use of abscisic acid (ABA) treated seedlings reduced tomato transplant heights by as much as 67 percent compared to untreated control plants. The 2006 research focused on plant height reduction as well as any differences in final yield on fresh market tomatoes, fresh market bell peppers, and processing tomatoes.

Plug trays were seeded on April 18 with 'BHN 685' plum tomatoes and 'Wahoo' bell peppers. ABA (abscisic acid) was applied as a foliar application at a rate of 100, 200, or 400 ppm five days before transplanting. Polyethyline glycol (PEG 8000), a polymer, was incorporated into the growing mix (Metro-Mix) at the rate of 20 g/liter of mix prior to seeding plug trays to control transplant height in vegetable transplants. Plots were mechanically transplanted into raised beds spaced 5 feet apart with in-row plant spacing of 12 inches.

Treatments were evaluated for their effect on transplant height control, field establishment, crop growth, and final marketable yield. Tomato plant height and stem diameter measurements were recorded prior to ABA application and five days after application (plant height only). Plant height, stem diameter, percent survival, and dry weights were recorded three weeks after transplanting. The same measurements plus plant height seven weeks after transplant were recorded on peppers.

For processing tomatoes, 'OX 52' and 'Gem 611' were seeded into 288-cell plug trays. Plants were grown under standard practices in the greenhouse. The four-week-old seedlings were then drench-treated with 200 or 400 ppm ABA solutions. Untreated controls were also compared to ABA treatments. Plants were measured prior to ABA application and again five days later at field transplanting. Plants were established on raised beds 5 feet apart with in-row plant spacing of 12 inches. Percent survival, plant height, stem diameter, and dry weight of five plants was collected three weeks after transplanting.

The use of ABA and PEG helped control transplant height prior to transplanting without adverse effects on final yield in both tomatoes and peppers. ABA can be an effective height control strategy, particularly when planting is delayed in the spring due to inclement weather at the time of field establishment. Unique cultivar responses to ABA in the 2006 study suggest that more research is needed to fine-tune this transplant height-control strategy. Further study in this area of transplant height control is planned.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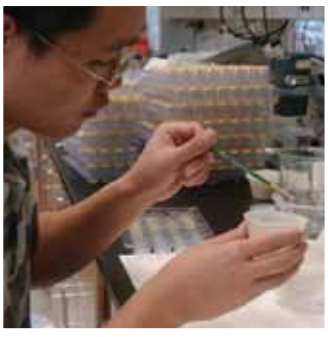
Publications, Presentations, and Graduate Students

Sharing knowledge through publications and professional meetings is an important part of research as is training graduate students for careers in research. Using data from SEEDS projects, OARDC scientists have reported publication of 576 peer-reviewed articles, bulletins, abstracts, and popular press articles. More than 1,100 presentations have been made in locations throughout the world. Eighty-five graduate students have been supported on SEEDS projects, providing them with the skills needed to move forward with scientific research in the future.



Presentations and Posters

Asea, G., B. Vivek, G. Bigirwa, P. Lipps, and R. C. Pratt. 2006. Poster. Characterization of Candidate Resistance QTL for Marker-Assisted Selection of Resistance to Multiple Foliar Pathogens of Maize. Crop Science Society of America International Meeting. Indianapolis, Indiana. 11/12/06.

Azevedo, M. S. P., Z. Zhang, A. M. Gonzalez, L. J. Saif, A. E. Yousef, and L. Yuan. 2007. Poster. Early Cytokine and TLR Responses in Genotobiotic Pigs Treated with Probiotic Lactic Acid Bacteria (LAB) and Infected with Human Rotavirus (HRV). 26th American Society for Virology Annual Meeting. Corvallis, Oregon. 7/14/07.

Azevedo, M. S. P., W. Zhang, A. M. Gonzalez, L. J. Saif, A. E. Yousef, and L. Yuan. 2006. Podium. Influence of Probiotic Lactic Acid Bacteria (LAB) on Cytokine Responses of Gnotobiotic Pigs Infected with Human Rotavirus (HRV). 25th Annual Meeting of American Society for Virology. University of Wisconsin-Madison. Madison, Wisconsin. 7/15/2006.

Basta, N. T., R. P. Lanno, A. Voigt, and S. Whitacre. 2006. Podium. Long-Term Ecological and Environmental Benefits from Land Application of Biosolids. Biosolids Specialty Workshop, Ohio Water Environment Association. Columbus, Ohio. 12/6/06.

Dami, I. E.. 2006. Poster. Chilling Requirements for Cool Climate Grape Cultivars. 6th International Cool Climate Symposium for Viticulture and Oenology. Christchurch, New Zealand. 2006.

Lanno, R. P., N. Basta, and A. Voigt. 2006. Podium. Extension of Laboratory-Derived Measures of Metal Bioavailability to Agricultural Land Treated with Sewage Sludge. Society of Toxicology and Environmental Chemistry, North America 27th Annual Meeting. Montreal, Quebec, Canada. 11/5/2006.

Mannig, Annegret, Luis Rodriguez-Romo, Ahmed Yousef, Luis Rodriguez-Saona. 2007. Poster. Application of Immunomagnetic Separation and Fourier-Transform Infrared Spectroscopy for Rapid Detection and Identification of *Salmonella* Serovars. PITTCON 2007. Chicago, Illinois. 2/27/07.

Mannig, Annegret, Louis Rodriguiez-Romo, Ahemed Yousef, Luis Rodriguez-Saona. 2006. Poster. Rapid Detection and Identification of *Salmonella* Serovars Using Immunomagnetic Separation and Fourier-Transform Infrared Spectroscopy. Institute of Food Technologists Annual Meeting. Orlando, Florida. 2006.

Mannig, Annegret, Luis Rodriguez-Romo, Ahmed Yousef, Luis Rodriguez-Saona. 2006. Podium. Rapid Detection and Identification of Salmonello Serovars Using Immunomagnetic Separation and Fourier-Transform Infrared Spectroscopy. Institute of Food Technologists Annual Meeting. Orlando, Florida. 2006.

Ndiaye, K., D. H. Poole, and J. L. Pate. 2007. Poster. Expression of mRNA for Membrane Progesterone Receptors by Bovine T Lymphocytes. Annual Meeting of the Society for the Study of Reproduction. San Antonio, Texas. 2007.

Pratt, R. C. 2004. Podium. Linkage of Molecular Markers to *Cercospora zeae-maydis* Resistance QTL in Maize. North-South Americas Molecular Biology Conference. Columbus, Ohio. 9/8/04.

Pratt, R. C. 2004. Podium. Molecular Marker-Assisted Selection Procedures for Improvement of Quality Protein Maize (QPM) Germ Plasm. Molecular Breeding for Crop Nutritional Enhancement Conference. Santo Domingo, Dominican Republic. 7/1/2004.

Pratt, R. C. and G. Asea. 2006. Podium. Marker-Assisted Selection for Resistance to Multiple Foliar Pathogens of Maize. NCR-167 Annual Conference. Guelph, Ontario, Canada. 2/20/06.

Precheur, R. 2007. Podium. Pumpkin Cultivars and Powdery Mildew Resistance. Empire State Vegetable Exposition. Syracuse, New York. 2/15/07.

Rebollar-Alviter, A., L. Madden, and M. A. Ellis. 2005. Podium. Pre- and Post-Infection Activity of Azoxystrobin, Pyraclostrobin, Mefenoxam, and Potassium Phosphite Against Leather Rot of Strawberry. Annual Meeting of American Phytopathological Society. Austin, Texas. 8/3/2005.

Rebollar-Alviter, A., L. Madden, S. Jeffers, and M. A. Ellis. 2005. Poster. Sensitivity of *Phytophthora cactorum* Isolates Causing Leather Rot and Crown Rot of Strawberry to the Strobilurin Fungicide Azoxystrobin. Annual Meeting of the American Phytopathological Society. Austin, Texas. 8/3/2005.

Rebollar-Alviter, A., L. V. Madden, and M. A. Ellis. 2006. Poster. Sensitivity of *Phytophthora cactorum* Isolates from Strawberry to Azoxystrobin and Pyraclostrobin. Annual Meeting of the American Phytopathological Society. Quebec City, Canada. 8/2/06.

Rhodes, L. H., R. J. Precheur, and R. M. Riedel. 2005. Podium. Update on Microdochium Blight. Western Agricultural Research Center, OARDC, The Ohio State University. South Charleston, Ohio. 8/11/05.

Rhodes, Landon. 2006. Podium. Field Testing for Microdochium Blight Resistance in Pumpkin. Pumpkin Field Day. Western Agricultural Research Station, OARDC, The Ohio State University. South Charleston, Ohio.

Rhodes, Landon. 2007. Podium Plectosporium (white speck) Resistance Trial in Pumpkins. Ohio Fruit and Vegetable Growers Congress. Columbus, Ohio. 1/15/07.

Rodewald, A. D. 2006. Podium. Towards a Mechanistic Understanding of Urban-Associated Changes in Bird Communities. North American Ornithological Conference. Veracruz, Mexico. 10/3/06.

Stinner, D. H., M. Kanter, L. Taylor, and J. Debolt. 2004. Podium. High-Oil Naked Oats. Organic Food and Farming Education and Research program (OFFER) Field Day. Ohio Agricultural Research and Development Center (OARDC), The Ohio State University, Wooster, Ohio. 7/1/2004.

Stinner, D., M. Kanter, L. Taylor, and J. DeBolt. 2004. Podium. High Oil Oats. Organic Food and Farming Education and Research program (OFFER) Field Day. Ohio Agricultural Research and Development Center (OARDC), The Ohio State University, Wooster, Ohio. 9/7/2005.

Stinner, D., M. Kanter, L. Taylor, and J. DeBolt. 2006. Podium. High-Oil Oats. Organic Food and Farming Education and Research program (OFFER) Field Day. Ohio Agricultural Research and Development Center (OARDC), The Ohio State University, Wooster, Ohio. 9/7/06.

Stinner, D. H., M. Kanter, and L. Taylor. 2003. Podium. High-Oil Oats. Organic Food and Farming Education and Research program (OFFER) Field Day. Ohio Agricultural Research and Development Center (OARDC), The Ohio State University, Wooster, Ohio. 8/27/2003.

Yuan, L., K. Wen, A. M. Gonzalez, M. S. P. Azevedo, W. Zhang, L. J. Saif. 2007. Podium. Rotavirus-Specific IFN-gamma Producing and Proliferating T Cell Responses to Human Rotavirus Infection and Vaccination in Gnotobiotic Pigs. The 4th International Conference on Vaccines for Enteric Diseases. Lisbon, Portugal. 4/24/07.

Yuan, L., M. S. P. Azevedo, W. Zhang, A. Gonzalez, T. Nguyen, K. Wen, A. Yousef, and L. J. Saif. 2006. Poster. Impact of Colonization of Probiotic Lactobacili on Development of T Cell Responses in Neonatal Gnotobiotic (Gn) Pigs Infected with Human Rotavirus (HRV). 25th Annual Meeting of American Society for Virology. University of Wisconsin-Madison. Madison, Wisconsin. 7/15/2006.

Zhang, W., M. S. P. Azevedo, A. Gonzalez, L. Saif, T. Nguyen, K. Wen, A. Yousef, and L. Yuan. 2006. Podium. Influence of Probiotic Lactobacillia Colonization on Neonatal B Cell Responses in a Gnotobiotic (Gn) Pig Model of Human Rotavirus (HRV) Infection and Disease. 25th Annual Meeting of American Society for Virology. University of Wisconsin-Madison. Madison, Wisconsin. 7/15/06.

Yuan, L., K. Wen, M. S. P. Azevedo, A. M. Gonzalez, W. Zhang, and L. J. Saif. 2007. Podium. Lactobacilli Influence Intestinal and Systemic Toll-like Receptor (TLR) 2, 3, 9 Expression in Gnotobiotic Pigs Infected with Human Rotavirus (HRV). 13th International Congress of Mucosal Immunology (ICMI). Tokyo, Japan. 7/9/2007.

Publications

Asea, G., B. Vivek, G. Bigirwa, P. Lipps, and R. C. Pratt. 2006. Characterization of Candidate Resistance QTL for Marker-Assisted Selection of Resistance to Multiple Foliar Pathogens of Maize. Crop Science Soc. Am. International Meeting, Nov. 12-16, Indianapolis, Ind. Abstract ID No.: 27631. http://a-c-s. confex.com/crops/2006am/c1/papers

Asea, G., P. E. Lipps, R. C. Prat, S. Gordon, and A. Edwamu. 2005. Development of Greenhouse Inoculation Procedures for Evaluation of Partial Resistance to *Cercospora zeaemaydis* in Maize. *Journal of Phytopathology* 153647-653.

Bennett, M. A., E. M. Grassbaugh, S. Contreras, M. Hofelich, and A. F. Evans. 2007. Vegetable Research Results. *Horticulture and Crop Science Series,* No. 751. . . 1-5. The Ohio State University, Department of Horticulture and Crop Science.

Broders, K. D., Lipps, P. E., and Dorrance, A. E. 2007. The description and phlylogenetic placement of two putative new species of *Pythium. Oomycete Molecular Genetics,* Asilomar, Pacific Grove, California. March 18-20, 2007.

Broders, K. D., Paul, P. A., Lipps, P. E. and Dorrance, A. E. 2007. Assessment of direct colony PCR and SSCP to determine the distribution of pathogenic *Pythium* spp. in Ohio. APS National Meeting. Abstract 97S14.

Broders, K. D., Lipps, P. E., Paul, P. A., and Dorrance, A. E. 2007. Evaluation of *Fusarium graminearum* with corn and soybean seed and seedling disease in Ohio. *Plant Disease* 911155-1160.

Broders, K. D., Lipps, P. E., Paul, P. A., and Dorrance, A. E. 2007. Characterization of *Pythium* spp. associated with corn and soybean seed and seedling disease in Ohio. *Plant Disease* 91727-735.

Cannon, M. J., and J. L. Pate. 2005. Presence of Membrane-Bound Progesterone Receptor mRNA in Bovine Peripheral Blood Monocular Cells. International Veterinary Immunology Symposium 2006.

Danforth, D. R., L. K. Arbogast, A. C. Ottebre, J. S. Ottobre, and C. I. Friedman. 2006. Identification of Gonadotropin Releasing Hormone Receptor Type I in the Ovine Ovary by Laser Capture Microdissection and Rel-time PCR. *Biological Reproduction.* Special Issue 175.

Danforth, D. R., S. Mortiz, T. Nguyen, L. K. Arbogast, A. C. Ottobre, and J. S. Ottobre. 2007. Regulation of Angiogenic Factors by PGF2a in the Ovine *Corpus Luteum. Biological Reproduction.* Special Issue.

Ellis, M. A., and A. Robollar-Alviter. 2004. New Developments in Small Fruit Fungicides. *Today's Grower* 17, No. 76-7.

Ndiaya, K., D. H. Poole, and J. L. Pate. 2007. Expression of mRNA for Membrane Progesterone Receptors by Bovine T Lymphocytes. *Biological Reproduction Abstracts.*

Pratt, R. C. and S. G. Gordon. 2006. Breeding for Resistance to Maize Foliar Pathogens. *Plant Breeding Reviews* 26119-173.

Pratt, R. C. and G. Asea. 2006. Marker-Assisted Selection for Resistance to Multiple Foliar Pathogens of Maize. *NCR-167 Annual Report.*

Rebollar-Alviter, A., L. Madden, S. Jeffers, and M. A. Ellis. 2005. Sensitivity of *Phytophthora Cactorum* Isolates Causing Leather Rot and Crown Rot of Strawberry to the Strobilurin Fungicide Azoxystrobin. *Phytopathology* 95:S87.

Rebollar-Alviter, A., L. V. Madden, and M. A. Ellis. 2006. Pre- and Post-Infection Activity of Azxoystrobin, Pyraclostrobin, Mefenoxam, and Phosphite Against Leather Rot of Strawberry Caused by *Phythophthora cactorum. Plant Disease* 91.

Robollar-Alviter, A., and Ellis, M. A. 2004. Evaluation of Strobilurin Fungicides (Abound and Cabrio), Potassium Phosphite (ProPhyt), and Ridomil Gold for Control of Leather Rot of Strawberry Caused by *Phytophthora cactorum.* North American Strawberry Growers' Association Newsletter.

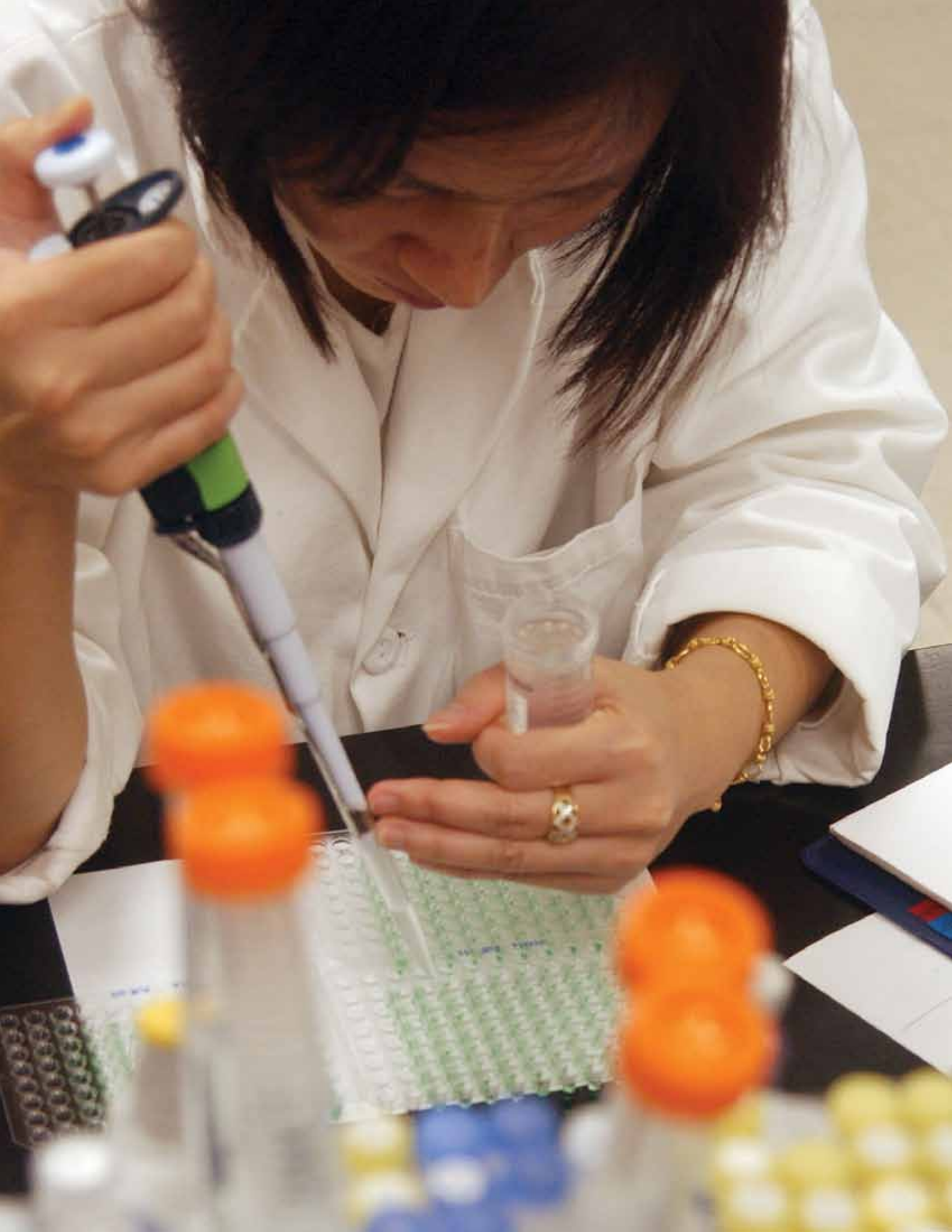
Rebollar-Alviter, A., L. V. Madden, and M. A. Ellis. 2005. Efficacy of Azoxystrobin, Pyraclostrobin, Potassium Phosphite, and Mefenoxam for Control of Strawberry Leather Rot Caused by *Phytophthora cactorum. Plant Health Progress* 10.1094/PHP-2005-0107-01-RS.

Rhodes, L. H., R. J. Precheur, R. M. Riedel, J. R. Jasinski, and M. R. Kelly. 2006. Field Evaluation of Cucurbita Plant Introductions for Resistance to White Speck (Plectosporium blight). *Plant Disease Management Reports,* Report 1:V132. DOI: 10.1094/PdMR01.

Student Funding

Zhang, Wei. Masters. Effects of Probiotic Lactic Acid Bacteria on Innate and B Cell Responses to Rotavirus. Spring 2007.

Roberts, Amanda. Masters. VEGF in Pre-Antral Follicular Development. Autumn 2006.



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